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Upper-crustal storage and differentiation of arc-front and rear-arc magmas confirmed by phase-equilibria experiments

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Debate continues regarding the conditions of magma differentiation beneath arc volcanoes. Contemporary models of transcrustal magma systems require polybaric crystallisation throughout the crust, while traditional models advocate differentiation in magma reservoirs most likely located in the upper crust. To explore differentiation conditions, phase equilibria experiments were conducted using a number of starting materials representing the diverse array of arc and rear-arc magma compositions, including a low-K tholeiitic basaltic andesite from Late (Tonga), a high-K calc-alkaline basalt from Taranaki (New Zealand) and a high-Mg andesite from Whakaari/White Island (New Zealand). Experiments using each of these starting materials consistently imply differentiation at pressures <200 MPa. The differing liquid lines of descent are instead controlled by parental magma compositions, volatile content and oxygen fugacity. Both tholeiitic and calc-alkaline differentiation trends require hydrous magmas (containing ~4-6 wt.% dissolved H_2O), however the liquid line of descent for the high-Mg andesite from Whakaari is best replicated under water-poor conditions (1 wt.% H_2O).